

## SCIENTIFIC RESULTS FROM THE MAMMAL SURVEY

## No. XVIII.

## REPORT ON THE HOUSE RATS OF INDIA, BURMA, AND CEYLON.

BY

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At the request of the Bombay Natural History Society, I undertook the comparison of the House Rats collected by the Mammal Survey with the Indian material in the British Museum. The work proved to be a complex and difficult task, but I have now reached three chief conclusions, namely:—(1) That the common Indian House Rat, which in the various Survey Reports has been listed either as “*Epimys rufescens*” or else as “*E. rufescens*, var. with white underparts,” is indistinguishable specifically from *Rattus*<sup>1</sup> *rattus*, Linnæus; (2) that this species shows in India, Burma and Ceylon, a definite geographical variation, so that many races or subspecies have now to be recognized; and (3) that the forms described as *R. nitidus* and *R. vicereus*, about the status of which there has been much controversy, are entitled to full specific rank, although they, too, are members of the *R. rattus* group.

In this paper *R. rattus*, as represented in the Mammal Survey collections, is dealt with exhaustively; and *R. nitidus* receives sufficient treatment to enable me to define a very interesting subspecies from the Chin Hills. With regard to *R. vicereus*, I must for the present content myself with publishing some skull measurements.

In presenting my results to the Society I am fully conscious of the fact that there is still plenty of room for further work upon these very difficult and somewhat unattractive animals. To obtain definite results one needs long series of careful measurements, external and cranial, accompanied by careful notes on the colour and mammae, from as many districts as possible. As a basis for further research I have given my original tables of skull measurements, with a description of the method of making them, at the end of this paper. If observers, dwelling in comparatively remote

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<sup>1</sup> As pointed out by Hollister (*P. Biol. Soc. Washington*, XXIX, p. 126, 1916), *Rattus* (misprinted *Ruttus*), Fischer (*Das National Museum der Naturgeschichte zu Paris*. Frankfurt am Main, 1803. Bd. II. p. 128), is a valid generic name and must replace *Epimys*, Trouessart (1880). This is unfortunate but quite unavoidable. I would take this opportunity of expressing my agreement with Thomas's statement that Fischer took *R. rattus* as the type of his genus, and not “*decumanus*” (*norvegicus*) as asserted by Hollister.

districts, could be induced to furnish us with corresponding data, each dealing with say 100 fully adult rats from his own district and carefully studied by himself, our knowledge of the geographical variation and its systematic value would very quickly be placed upon a secure foundation.

Key to Indian, Cinghalese, & Burmese members of the group based principally upon external characters):---

- I. Tail bi-coloured ... .. *Rattus vicereus*, Bonhote.
- II. Tail unicoloured.

- A. Fur very fine; lacking all trace of bristles. Nasal length exceeding 40 per cent. of the condylo-basal length of skull.

- a. Tail longer, about 108 per cent. of length of head and body. Fur long and thick; underparts silvery or hoary. *Rattus nitidus nitidus*, Hodgson.

- b. Tail scarcely longer than head and body. Fur short and thin; underparts not silvery, frequently with rusty tinge ... *Rattus nitidus obsoletus*, Hinton.

- B. Fur coarser, usually with many bristles (though these vary in strength). Nasals usually less than 40 per cent. of the condylo-basal length of the skull.

- a. Ventral fur white to bases; lateral line of demarcation usually well defined.

- a<sup>1</sup> Mammæ normally 3-3=12.

- a<sup>2</sup> Pectoral mammæ not undergoing reduction.

- a<sup>3</sup> Tail relatively short, averaging less than 120 per cent. of the head and body length.

- a<sup>4</sup> Dorsal colour dull greyish brown; audital bullæ very large ... *R. rattus tathkonensis*, Hinton.

- b<sup>4</sup> Dorsal colour with an ochreous tinge; audital bullæ medium sized... *R. rattus khyensis*, Hinton.

- $b^3$  Tail relatively long, averaging more than 120 per cent. of the head and body length.  
 $a^4$  Fur of underparts long and soft. Dorsal colour cold grey or yellow ... *R. rattus gangetriannus*, Hinton.  
 $b^4$  Ventral fur shorter and harsher.  
 $a^5$  Dorsal colour black, grizzled with tawny. *Rattus macmillani*, Hinton.  
 $b$  Dorsal colour rich dark olive brown ... *R. rattus sikkimensis*, Hinton.  
 $b^2$  Pectoral mammae undergoing reduction. Tail short, averaging about 108 per cent. of head and body length. Dorsal colour umber ... *R. rattus tikos*, Hinton.  
 $b$  Mammae normally 2-3=10  
 $a^2$  Fur full; dorsal colour warm and bright. Tail length variable.  
 $a^3$  Dorsal colour olive brown.  
 $a^4$  Size larger (H. & B. averaging 145; HF. 32); tail shorter, about 123 per cent. of head and body length ... *R. rattus tiste*, Hinton.  
 $b^4$  Size smaller (H. & B. averaging 137; HF. 31); tail longer, about 131 per cent. of head and body length ... *R. rattus bhotia*, Hinton.  
 $b^3$  Dorsal colour not olive brown.  
 $a^4$  Backs bright clay or golden brown; tail very long, more than 150 per cent. of head and body length ... *R. rattus satara*, Hinton.

$b^4$  Backs inclining to  
rufous; whitish bristles  
usually present.

$a^5$  Tail shorter, about  
122 per cent. of head  
and body length ... *R. r. wroughtoni*,  
Hinton.

$b^5$  Tail longer, about  
132 per cent. of  
head and body  
length ... *R. r. khandianus*,  
Kelaart.

$b^2$  Fur rather short, thin and  
harsh, but usually not spiny;  
dorsal colour cold and dull;  
tail long, about 135 per  
cent. of head and body  
length.

$a^3$  Dorsal colour warmer,  
near cinnamon brown or  
tawny ... *R. rattus arboreus*,  
Buch.—Ham.

$b^3$  Dorsal colour colder and  
greyish.

$a^4$  Dorsal colour drab;  
long black hairs tend-  
ing to form a mid-  
dorsal stripe... *R. rattus narbadæ*,  
Hinton.

$b^4$  Dorsal colour drab  
grey; mid-dorsal line  
decidedly darkened by  
black hairs; white of  
belly duller ... *R. rattus girensis*,  
Hinton.

$b$ . Ventral fur slaty based; no  
sharp line of demarcation  
along flanks.

$a^1$  Fur long, dense, and soft;  
ventral fur white tipped;  
tail short, less than 120 per  
cent. of head and body  
length ... *Rattus kelaarti*,  
Wroughton.

$b^1$  Fur thinner and harsher;  
ventral fur not white tipped;



tail long, more than 120  
per cent. of head and body  
length.

*a*<sup>2</sup> Dorsal colour rufous;  
hair of belly rough with  
rusty tinge ... ..

*R. rattus rufescens*,  
Gray.

*R. rattus nemoralis*,  
Blyth.

*b*<sup>2</sup>. Dorsal colour rarely ru-  
fous; bellies without  
rusty tinge.

*a*<sup>3</sup>. Backs grey or brown;  
belly light grey to  
dusky, rough or  
smooth .....

*R. rattus alexandrinus*,  
Geoff.

*b*<sup>3</sup>. Back black; belly  
bluish grey, sleek  
haired .....

*R. rattus rattus*,  
Linnæus.

# 1. *Rattus rattus*, Linnæus.

A brief reference to the history of this species in Europe will greatly facilitate both the presentation and the understanding of the Indian facts. *Mus rattus*, Linnæus (*Syst. Nat.*, 10th ed., 1758, p. 61), was described from Upsala, Sweden, and based upon the well known Black Rat. At or a little before the date when Linnæus wrote, this animal was the common house rat of Europe, but later it was almost completely replaced by the Brown Rat (*R. norvegicus*, Berkenhout). Typical *R. rattus* is characterized externally by its dusky coloration, its back being usually black and its underparts of a dark brownish grey or slate. In 1803, Geoffroy (*Cat. Mamm. Mus. Nat. d' Hist. Nat. Paris*, p. 192) named his *Mus alexandrinus* from Alexandria, Egypt; and in 1812, he gave a full description and figure (*Descr. de l'Égypte, Hist. Nat. II.*, p. 735; Atlas Pl. V, fig. 1). From the latter account it is evident that *Mus alexandrinus* is a rat in which the back is buffy brown, this colour brightening gradually on the flanks to pass insensibly into the whitish or yellowish grey of the underparts. In 1814, Rafinesque (*Préc. des Découv. et Trav. Somnologiques*, p. 13) described his "*Musculus frugivorus*", from Sicily; and in 1825, Savi (*Nuovo Giorn. dei Letterati*, Pisa, X, p. 74) re-described the same form from Pisa, Italy, under the name of *Mus tectorum*. This Sicilian and Italian rat is brown above as in *alexandrinus*, but it possesses a softer coat, and the fur of its underparts is of a pure

white or lemon yellow colour, separated on each side from the rich tint of the flanks by a sharp line of demarcation.

In 1866, de l'Isle (*Ann. Sc. Nat. (Zool.)* IV, p. 173) described a series of breeding experiments which he had made with "*Mus rattus*" and "*Mus alexandrinus*"; by the latter name Rafinesque's *frugivorus* and not Geoffroy's *alexandrinus* seems to have been implied. Among the progeny of the various crosses effected, were some peculiar rats which de l'Isle called "*semialexandrines*"; judging from the description these must have corresponded rather closely with Geoffroy's *alexandrinus* in outward appearance. De l'Isle demonstrated that *rattus*, *frugivorus*, and *alexandrinus* are nothing but colour phases of one and the same species, viz., *R. rattus*, Linnaeus. His experiments suggested that the wild-coloured *frugivorus* represents the primitive stock, properly belonging to warm temperate or sub-tropical regions; and that the dusky coloration of typical *rattus* is simply a change of hue brought about by the indoor life forced upon the species by its successful endeavours to colonize colder lands. The species appears to have made its way to north-western Europe at about the time of the Crusaders; and by the 16th century, at the latest, it had fully assumed there its familiar dusky garb. Geoffroy's *alexandrinus* may be regarded as an intermediate stage, the belly having acquired within doors a darker colour, and having lost its sharp contrast with the flank tint, although dorsal darkening has not taken place to any considerable extent. In examining a large, cosmopolitan collection of rats, it is quite easy to find and arrange a series of individuals connecting *frugivorus* with *alexandrinus*, and especially the latter form with typical *rattus*.

Mendelians, as Bonhote (*P.Z.S.*, 1910, p. 653 and 1912, p. 6), argue that these three forms of *rattus* have arisen as mutations. There is nothing inconsistent between this view and the history of typical *rattus* as outlined above. In any case the colour differentiation in the three races is susceptible of a physiological explanation.

Recently the three European races have been treated as subspecies, the characters of which may be tabulated as follows:—

A.—Dorsal parts black.

Ventral parts dusky; the hairs on belly  
short and usually adpressed ... .. *R. rattus rattus*, Linn.

B.—Dorsal parts brown.

a. Ventral parts not usually conspicuously lighter than flanks; ventral hairs with slaty bases; coat harsh and usually thin ... .. *R. rattus alexandrinus*, Geoff.

b. Ventral parts light coloured, sharply contrasted with flanks; ventral hairs

mostly pure white or lemon coloured  
 to their bases; coat soft and usually  
 thick... .. *R. rattus frugivorus*,  
 Raf.

Specimens intergrading in appearance between these subspecies usually come from colonies of mixed origin, *e.g.*, those of ships or of large towns. Where opportunities for pure breeding occur, as on small islands, each of these subspecies breeds perfectly true to type. It is, of course, unfortunate that the typical form of the species, in a technical sense, is *R. r. rattus* (which is little better than a domestic animal), and not the really wild form, *R. r. frugivorus*.

Turning now to India, the rats listed in the Survey Reports as "*rufescens*", or "*rufescens* var.", afford us with problems of considerable complexity. In the first place, although I am unable to find any character in the dentition, skull, or external parts, to distinguish any of them satisfactorily from *R. rattus*, the range of variation is enormous. Indian skulls with well worn teeth have the condylo-basal length ranging between 34 and 44 mm. The fur may be long, soft, dense and without spines; or it may be short, thin, and harsh, with numerous spiny bristles. The dorsal colour varies between bright rufous, or warm olivaceous tints on the one hand, to dull tawny, or cold mixtures of black and grey on the other. The underparts may be pure white or pale lemon; or they may be slaty, with or without a rusty tinge or bloom. The hands and feet may be white or yellowish above, with or without dusky markings; or they may be wholly blackish brown in colour. The mammary formula may be 2-3=10 or 3-3=12. Every intermediate stage between the extremes indicated may be found in the collections before me. Nevertheless, much of this variation has a definite geographical value; and where long series are available from one locality or district, the rats are usually found to conform closely to one or more definite local types. It is therefore possible to define a considerable number of local races or subspecies.

The members of the *rattus* group seem to afford an exception to the rule, so general for wild mammals, that not more than one subspecies of a given species, or not more than one of two or more very closely allied species can inhabit a given locality. But these rats are capable of playing many parts in warm countries; thus we find them following a free life in fields and hedgerows, far from houses, or high up among the branches of trees in forests; or they may lead a purely parasitic existence in human habitations or shelters. It is a poor sort of locality which refuses at least two "niches in nature" for *rattus*; and the semi-domesticated stocks, at all events, of this species have frequent opportunities for prospecting and touring conferred upon them by railways, wheeled carriages, and shipping.

Like other murines, this species shows, within certain limits, an almost startling plasticity. Its structure responds readily to the demands of purely local requirements. If necessary colour or the quality of the coat are modified; a change in diet induces modifications in the development or the "set" of the muscles of mastication; and these in turn mould the skull, or lead to the lengthening or shortening of the tooth-rows.

Considerations such as those mentioned in the preceding paragraphs lead us to realize the hopelessness of attempting to disentangle the history of the rats in large towns or ports like Calcutta or Bombay. In such places the rat population is a motley horde, representing the progeny of truly native rats crossed with the descendants of old wanderers and with newcomers not only from the neighbouring hinterland but from all parts of the world. It is therefore only in the more remote parts of the country that we can reasonably expect some measure of success to crown such efforts.

The material collected by the Mammal Survey is most extensive, and although gaps exist it is now possible to gain a broad idea of the chief facts relating to the distribution and variation of the present species in India. Save for the conclusion that *R. nitidus* is entitled to full specific rank, the conclusions of this paper are little more than natural extensions of those reached by Thomas in 1881, upon the basis of comparatively insignificant material.

In North-Western India, Sind and the Punjab, the prevalent race seems to be identical with *R. r. alexandrinus*. Further east, from the Himalayan districts of Kumaon and Sikkim southwards to Travancore and Ceylon, and through Assam and Burma to South Tenasserim, the common rat is that called "var. *rufescens*" by Thomas and Blanford. This is, however, split into a number of local races. The most striking and widespread variations are those to which attention has so frequently been drawn in the Reports, *viz.*, a dark bellied variety and a variety with pure white underparts. Mr. Wroughton has already commented upon the remarkable distribution of these two types (Report No. 15, *J. B. N. H. S.*, Vol. XXIII, p. 295).

At the higher collecting stations in Kumaon only white bellied specimens were found; at some lower stations white and dark bellied rats were present together in apparently equal numbers; while at still lower elevations dark bellied rats alone occurred. Again in Sikkim and at Hasimara, Bhutan Duars, all are of the white bellied type, although a certain proportion have slaty bases to their ventral hairs. In Bengal and Orissa, and in the southern part of the peninsula as at Travancore, as well as through Assam, Burma, and Tenasserim, the rats are uniformly of the white-bellied type. From South

Coorg northwards along the Western Ghats in Mysore ; in the Central Provinces and in Kathiawar, the white-bellied type is present but accompanied by rats of the dark bellied type. In Cutch, Palanpur, Gwalior, Nimar, Western Khandesh, Berars and Bellary, only dark bellied rats were collected. Similar facts were noted by Major Lloyd, and he tells us that of many thousands examined from the Punjab only some few from three villages in the Amritsar and Lahore districts were of the light bellied type (Rec. Ind. Mus. III, p. 20).

Such distributional facts viewed in gross appear at first sight to afford the strongest possible evidence in support of the idea that white bellied and dark bellied types belong to distinct subspecies if not species. The initial object of my work, indeed, was to test such a belief.

Mr. Wroughton has already brought before the Society (*J. B. N. H. S.*, Vol. XXIII, p. 474) the view that the white bellied forms of *R. rattus* in India and Burma represent the primitive wild form of the species ; and that the dark bellied types are parasites, the darkening of the underparts, no less than the darkening of the back, being the outward indication of domesticity or parasitism. In support of this view, one may point to the general similarity of the Indian white bellied forms to the wild race, *R. r. frugivorus*, of the Mediterranean region ; to their wide distribution, both in the mountains and in the plains, in India and Burma : and to the wild life which many of them lead in the jungles. Further on investigating these white bellied rats in detail, we find that they behave very much as do normal wild mammals as regards geographical variation and that it is therefore possible and comparatively easy to arrange them in geographical races or subspecies.

With regard to the dark bellied rats the case is different. They are largely restricted to districts possessing substantial houses ; they are more frequently caught within doors and far less frequently in the open. Close investigation of their structure leads to nothing but confusion ; the variation is largely individual or colonial, and scarcely at all geographical. In some districts, as in Kumaon, such rats seem to have little or no connection with the white bellied forms ; in other places, they differ from their white bellied companions merely in colour and to a trifling extent in skull—the cranial differences being readily susceptible of a physiological explanation, as is shown below in discussing the rats of the Central Provinces and Kathiawar ; finally, in still other districts, the difference is purely one of colour and even that sometimes breaks down. One concludes from this that the dark bellied rats are of diverse origin ; some seem to have been produced, in the localities where they are now found, from the local white bellied race ; others have found their way to their present habitations from other more or less remote districts of



the country, or even from abroad; and lastly, many are doubtless to be regarded as the mixed descendants of both native and imported stocks.

1. *Rattus rattus tistie*, subsp. n.

1916. *Epimys rufescens*, variety with white underparts, Wroughton, Report No. 23, Sikkim and Bengal Terai, *J. Bombay Nat. Hist. Soc.*, Vol. xxiv, p. 489 (in part).

Type.—A female (B. M. No. 17.7.2.13; Original No. 393) collected at Pashok, Sikkim, by N. A. Baptista on 16th July 1915; presented to the National Collection by the Bombay Nat. Hist. Soc.

*Distribution*.—Sikkim.

*Material examined*.—122 (60 ♂, 62 ♀), from Pashok (3,500'); 14 (7 ♂, 7 ♀), from Narbong (2,000'); 7 (3 ♂, 4 ♀), from Rongli (2,700'); 1 ♂ from Gopaldhara (4,720'); 3 (1 ♂, 2 ♀) from Batasia, Tonglu (6,000'); 3 (1 ♂, 2 ♀) from Gangtok (6,000'); and 4 (2 ♂, 2 ♀) from Sedonchen (6,500'). Total 154 (75 ♂ 79 ♀).

*Description*.—The fur is soft and thick, without spines on the back; and not particularly long on the underparts. In the typical series from Pashok the backs are dark olive-brown and very uniform in colour. The ventral colouration is of two types; in about a third of the specimens from the type locality the ventral hairs have slaty bases and light tips and in these specimens a suffusion of buff, recalling what is seen in many forms of *Apodemus*, is sometimes present, forming a median thoracic stripe and occasionally even a pectoral collar. In many other specimens, however, the ventral hairs are white from their tips to their bases; while in others pure white and slaty-based hairs occur together in variable proportions. The mammary formula of females appears to be constantly 2-3=10.

The following are the collector's measurements\* of those specimens from Pashok whose skulls were specially investigated ventral hairs:—

No. 288	♂, 3rd July 1915,	145—168—31—21	slaty bases.
„ 325	♂, 8th „ „	161—194—32—22	slaty bases.
„ 625	♂, 18th Aug. „	160—183—33—23	slaty bases.
„ 234	♀, 27th June „	158—180—32—23	intermediate.
„ 243	♀, 28th „ „	150—180—31—22	intermediate.
„ 335	♀, 9th July „	153—180—30—22	pure white.
„ 393	♀, 16th „ „	155—196—32—21	do. type.
„ 414	♀, 19th „ „	135—169—32—21	slaty bases.
„ 482	♀, 27th „ „	149— —32—22	pure white.
„ 689	♀, 3rd Sept. „	138— —31—21	slaty bases.

\* These dimensions are:—(1) Head and body. (2) Tail, without terminal hair. (3) Hindfoot, without claws. (4, Ear from base.

The following are averages (absolute and percentages of the head and body length) of specimens in adult pelage, of both sexes and all from Pashok:—

(1) Average of 31 (Head and body ranging between 122 and 161) with *slaty* bases to the ventral hairs =  
 $143-174-32.1-21 = 100-122-22.5-14.7.$

(2) Average of 81 (Head and body ranging between 120 and 171) comprising *intermediate* specimens as well as those with *pure white* ventral hairs =  
 $147-181-32.1-21.3 = 100-124-21.8-14.5.$

(3) Average of 50 10-mammæd females (ventral coloration of both types) =  $144-177-31.5-20.9 = 100-123-21.9-14.5.$

(4) Average of 40 white-bellied females (a few not included in the total of average 3, because their mammæ could not be counted on the skins) =  $145-179-31.4-21 = 100-123-21.6-14.5.$

In no female did the length of the head and body exceed 161 mm. Larger individuals were not only always males, but were all of the pure white-bellied type; I suspect that some of these really belong to *R. r. silckimensis* (described below), for without examining the skulls\* it is sometimes difficult to discriminate between the males of that sub-species and those of the white-bellied phase of the present form.

The following table shows the decreasing values of the average relative lengths of the tail, hind-feet and ears in *R. r. tistæ* at successive stages of growth; for systematic purposes it is instructive to compare it with the similar table given latter for the associated *R. r. silckimensis*:—

## PASHOK.

<i>R. r. tistæ.</i>			Average length in percentages of Head and Body, H. & B., Tail, Hind-foot, Ear.
Head and body mm.	Sex.	No. of specimens.	
100 to 120	♂ & ♀	14	100--127--26.7 --17.1
121 to 139	♂	12	100--129--24.2 --15.5
Do.	♀	21	100--120--23.4 --15.1
140 to 149	♂	16	100--125--22.4 --14.9
Do.	♀	18	100--125--22.8 --14.4
150 to 159	♂	15	100--129--21.3 --14.1
Do.	♀	15	100--119--20.9 --14
160	♀	1	100--111--20 --13.1
161	♂	2	100--118--20.25--14
160 to 171	♂	10	100--121--20.25--14.8†

\* It was not possible to clean all the many skulls collected and often the search for the skull of some particularly fine skin revealed the annoying fact that that particular skull had been smashed by the trap.

† As noticed above these large rats are probably in part referable to *R. r. silckimensis*.



The skull is small (average condylo-basal length between 37.7 and 38.4 mm., *i.e.*, about 2 mm. less than in European races of *R. rattus* or in *R. r. sikkimensis*), and therefore the cranial width appears relatively great, showing an increase equal to from 1 to 1.7 per cent. of the condylo-basal length (see Table 11). Judging from dimensions 6 and 7, as well as from the relation of the latter to the cranial width, (dimension 3), the temporal muscles are no weaker than in *R. r. alexandrinus*. Posteriorly, even in old skulls, the temporal lines are at a level considerably below the ends of the interparietal; and thus the upper surface of each parietal articulates with the supraoccipital by a conspicuous tongue. The temporal wing of each parietal is small, its length being equal to less than half the distance between the lambdoidal crest and the antero-superior extremity of the squamosal.

In relation to the condylo-basal length, the palatal length, masseteric plate and tooth-rows are distinctly longer, although the nasals, diastema and palatal foramina are about as in European *rattus*. The pterygoid region is short, for while the distance condyle to bulla is about as in *R. r. frugivorus*, condyle to m. 3, in relation to the condylo-basal length, is about 3% shorter. The cheek-teeth are as in European *rattus*.

*Local variation:—*

NARBONG (2,000').

14 (7 ♂, 7 ♀) collected by Mr. Crump; of these 2 are in the British Museum (Nos. 15, 9, 1, 152-153). The dimensions of the more important are:—

6439 ♂, 10 March 1915,	176—206—35—23,	Weight 6 ozs.
152 6473 ♂, 14	„ „ 161—195—34—23	
6474 ♂, „ „	„ „ 165—180—32—22	
6479 ♀, 15	„ „ 154—176—33—21,	Weight 4 ozs
153 6480 ♀, „ „	„ „ 156—179—31—24	„ 4 „
6487 ♀, „ „	„ „ 144—171—31—20	„ 3 „
Average of 14:—	156—182—32.2—21.7	
Do. per cent. of H & B:—	100—117—20.7—13.9	

10 mammæ are apparent in each of 4 of the female skins.

These rats have rather bright backs and are much like those from Rongli noticed below. In 5 (3 ♂, 2 ♀) the bellies are pure white, although in 4 of these some of the hairs on the chest have slaty bases. In the remainder the majority of the ventral hairs have slaty bases and in some a median stripe of buff is developed on the thorax. The whole series is, however, very uniform really, for even the bellies, despite the differences just noted, appear remarkably similar when viewed from a little distance. Skull as in typical series.

## . BATASIA, TONGLU (6,000').

3 (1 ♂, 2 ♀) collected by Mr. Crump (2 in British Museum Nos. 15, 9, 1, 150-151). Dimensions:—

·150 6394 ♂, 25 Feb. 1915, 163—188—35—22, Weight 5 ozs.

6395 ♀, " " " 155—183—35—21 " 5 "

·151 6411 ♀, 27 " " 151—206—31—21 " 4 "

Each female has 10 mammæ. No. 6411 is quite like those from Pashok, but the other two have much brighter yellowish-brown backs, lined with black. In the two registered specimens, the ventral fur is long and soft; certain of the hairs are buff-tipped and form an indistinct median thoracic stripe and pectoral collar; most of these buff-tipped hairs have deep slaty bases, but the dark tint is almost completely hidden by the long light tips. Elsewhere all the ventral hairs, save the usual bright buff ones around the genitalia, are white throughout. In No. 6395, the majority of the ventral hairs have a very pale greyish basal tinge. The feet are ashy grey, with a slight tinge of yellow in the male. The skulls are imperfect but agree apparently with those from Pashok.

## RONGLI (2,700').

7 (3 ♂ 4 ♀) collected by Mr. Crump; of these 4 are now in the British Museum and their dimensions are:—

B. M. 15, 9, 1.

·137 5847 ♂, 24 Nov. 1914, 158—183—34—21, Weight  $4\frac{1}{2}$  ozs.

·139 5825 ♀, 22 " " 156—185—33—21 "  $4\frac{1}{2}$  "

·141 5849 ♀, 25 " " 153—170—31—21 "  $4\frac{3}{4}$  "

·142 5850 ♀, " " " 148—167—32—21 " 4 "

Nos. ·139 and ·141 have each 10 mammæ.

This series is interesting as showing that sometimes the differences in ventral coloration, already alluded to, are apparently correlated with slight differences in the dorsal colour. Thus Nos. 5847 and 5825 have bellies of a pronounced *Apodemus* type, i.e., the ventral hairs have deep slaty bases and a heavy and rather generally distributed suffusion of buff; in these two the backs also are darker than in the following. Nos. 5849 and 5850 have silvery bellies with the ventral hair bases of a distinctly lighter grey than in the first mentioned specimens; their backs have more of the yellowish-brown tints seen in some of the specimens from Gangtok and Batasia. The feet, moreover, are inclined to be lighter in the lighter bellied type. Similar differences are shown by the three unregistered specimens from this locality. The skulls of ·137 and ·141 were measured (Table 1) and apparently agree with those from Pashok.

## SEDONCHEN (6,500').

4 (2 ♂, 2 ♀), 3 being adult, collected by Mr. Crump. Dimensions:—

5769 ♂, 14 Nov. 1914, 154—178—31—21, Weight  $4\frac{1}{2}$  ozs.

5748 ♀, 10 .. .., 132—145—30—20 ..  $2\frac{3}{4}$  ..

5779 ♀, 15 .. .., 140—152—29—19

The first two have the backs yellowish-brown, lined with black; their bellies are whitish, the ventral hairs having deep slaty bases and white tips; their feet have dusky markings above and the tails are dark. No. 5779 has a darker belly and shows a trace of a buff stripe and collar.

## GANGTOK (6,000').

3 (1 ♂, 2 ♀) collected by Mr. Crump; 2 in British Museum (Nos. 15. 9. 1. 143/144). Dimensions:—

·143 5875 ♂, 3 Dec. 1914, 167—191—33—21, Weight  $5\frac{1}{2}$  ozs.

·144 5871 ♀, 2 .. .., 150—179—31—20

5876 ♀, 3 .. .., 140—165—32—22 Weight 3 ozs.

No. ·144 is dark above, while ·143 is yellowish-brown as in the ♂ from Batasia. In the former (·144) a few hairs along the mid-throacic line have buff tips; in the latter (·143) many on the throat and chest are buff-tipped and form a complete collar and median stripe. All the ventral hairs have deep slaty bases and the feet are perhaps a shade darker than in the specimens from Batasia. The skull of ·143 was measured (Table I) and does not appear to differ from those from Pashok.

## GOPALDAHRA (4,720').

1 ♂ (No. 24) collected by Mr. N. A. Baptista, on 2nd May 1915, differs from the other specimens from this locality, referred below to *R. sikkimensis* in having the bases of the ventral hairs deep slaty. It may perhaps be referred to *R. r. tista*. The dimensions of this specimen are:—146—198—32—23.

2. *Rattus rattus bhotia*, subsp. n.

*Type*:—A male (B. M. No. 17. 7. 2. 20; Original No. 1185), collected at Hazimara, Bhutan Douars, on 26th November 1915, by Mr. N. A. Baptista; presented to the British Museum by the Bombay Natural History Society.

*Distribution*:—Known only from the type locality.

*Material examined*:—124 (66 ♂, 58 ♀) collected by Mr. N. A. Baptista between 22nd October 1915 and 13th January 1916.

*Description*:—This is a soft-furred rat closely resembling *R. r. tista* in general appearance. It differs, from the latter subspecies in its smaller size, the hindfoot and ear averaging in 111 adults, 31 and 20.4 instead of 32 and 21.3, respectively; the tail also is

relatively longer, averaging in the adults 131 per cent. of the head and body measurement instead of about 123 per cent. Mammary formula constantly 2-3=10.

Taken as a whole the series shows brighter backs than those of typical *R. r. tistæ* from Pashok, the general dorsal colour being a rufous tint near "Brussels brown"; many of the specimens are, however, as dark in hue as any from Pashok. As in *R. r. tistæ* the ventral coloration is of two types; 62 (32 ♂, 30 ♀) have pure white bellies, the ventral hairs being white to their bases; in 18 (15 ♂, 3 ♀) the bellies are white also, but slaty bases are developed by many of the hairs on the chest and throat, forming chest spots or stripes of large size; in 6 (2 ♂, 4 ♀) pure white and slaty-based hairs are equal in number and distribution; lastly in 38 (17 ♂, 21 ♀) practically all the hairs have slaty bases and light tips, and in these specimens a median stripe-like suffusion of buff is sometimes developed. The preponderance of pure-white bellied individuals is therefore as well marked in this subspecies as in the typical series of *R. r. tistæ* from Pashok; and it may be suggested that the two types of ventral coloration in both forms are "mutations" obeying Mendel's law in inheritance.

The following are the dimensions of the specimens whose skulls were specially investigated:—

				Ventral hairs:—
1048 ♂,	3 Nov. 1915,	131—190—33—22,	Intermediate.	
1125 ♂,	14 .. ..	145—194—33—21,	Pure white.	
1140 ♂,	17 .. ..	147—184—34—21,	Slaty bases.	
1185 ♂,	26 .. ..	149—211—33—20	Do.	
1208 ♂,	30 .. ..	142—200—32—21,	Pure white.	
1221 ♂,	3 Dec. ..	143—184—30—21	Do.	
1241 ♂,	7 .. ..	141—187—32—21	Do.	
980 ♀,	22 Oct. ..	131—186—34—20,	Intermediate.	
Average of 111 adults:—137—179—31—20.4				

.. per cent. of H. and B.=100—131—22.6—14.9

The following table shows the changes in the average proportions correlated with growth or larger size and it may be compared with that given at p. 69 above:—

Head and Body. mm.	No. of speci- mens.	Average % of head & body form- ed by H. & B. Tail, Hind-foot, Ear.
100 to 120	19	100—133 -25.7—17.1
121 to 139	60	100—132.5—23.4—15.2
140 to 149	36	100—127.5—21.7—14.3
150 to 155	7	100—123 -20.6—14.2

The skull and teeth do not differ from those of *R. r. tistæ* in any important respect.

### 3. *Rattus rattus arboreus*, Buchanan-Hamilton.

1851. *Mus arboreus*, Buchanan Hamilton in Horsfield, *Cat. Mamm. Mus. E. India Co., London*, 1851, p. 161; described from "Bengal," the type being unknown.

1865. *Mus rufescens*, Blyth, *Cat. Mamm. Mus. As. Soc., Calcutta*, p. 115 (in part); Jerdon (in part).

1881. *Mus alexandrinus*, a. typical var., Thomas, *P. Z. S.* 1881, p. 532 (in part).

In a portion of his MS. (first published by Horsfield, *loc. cit. supra*). Dr. Buchanan Hamilton described a rat said to live in the cocoanut trees and bamboos of Bengal. The upper parts are said to be "dark iron-grey, consisting of black and tawny hairs, of which the former are the longest and most numerous. The lower parts and legs are white; the naked parts of the nose and toes are pale flesh colour." The head and body lengths of a full-grown male and female are given as 7" and 8½", their tails as 7½" and 9" respectively. If we suppose these measurements to have been taken on stretched skins, then this description, so far as it goes, will apply to many of the specimens obtained by the Mammal Survey in Bihar and Orissa. The Survey material indicates that the race inhabiting this part of Bengal is deserving of subspecific recognition, and I therefore propose to revive the name *arboreus* and to use it for the subspecies in question. Mr. Thomas (*P. Z. S.*, 1881, p. 532) has pointed out long ago that *arboreus* is based upon the description (and a drawing) cited above and not upon the specimen mentioned by Horsfield which is a Brown Rat (*R. norvegicus*). Mr. Wroughton (*J. Bombay Nat. Hist. Soc.*, Vol. XXI, p. 1190) has already stated that should a name be required for the "white bellied variety of *rufescens*" then "*arboreus*, Buchaman Hamilton, is available and most apposite."

*Distribution*:—Probably throughout the greater part of Bengal to the south and west of the Ganges.

*Material examined*:—In addition to some old material in the British Museum I have had at my disposal the following 72 specimens collected for the Mammal Survey by Mr. C. A. Crump:—17 (4 ♂ 13 ♀) from Daltonganj; 1 (♂) from Palamau; 3 (♂) from Barkagaon; 1 (♀) from Jagodih; 4 (2 ♂, 2 ♀) from Lohra; 19 (7 ♂, 12 ♀) from Gajhundi; 5 (3 ♂, 2 ♀) from Singar; 2 (♂ and ♀) from Nimiaghat; 15 (8 ♂, 7 ♀) from Pareshnath Hill; 1 (♀) from Sangajata, Chaibassa; and 4 (2 ♂, 2 ♀) from Luia, Chaibassa. Specimens from this collection are registered in the British Museum under the serial number 15.4.3.—



*Description*.—This is a relatively long-tailed race, with usually a short, thin, rather harsh, though not spiny coat. The general colour of the back is near “cinnamon brown” or tawny, greyer in young or quite unbleached specimens, yellower when older, much worn or bleached. The underparts are pure white or cream-coloured, the ventral hairs being light to their bases. The hairs around the genitalia are, however, often ochraceous. The feet are light, sometimes quite white, sometimes tawny above. The tail is a uniform light brown.

The mammae were counted in 37 females; in 36 the formula was 2-3=10, 1 had 11 mammae.

In the 72 specimens in adult pelage from Bihar and Orissa, enumerated above the head and body length varies between 134 and 174 mm. The Collector's measurements give the following averages and percentages:—

Average of 72 adults from Bihar

and Orissa:— ... 159—215—31·6—23·2

Average of Head & Body length : 100—135—19·9—14·6

The specimens from all localities mentioned conform closely to these averages. The following table shows the variation of proportions with growth and may be compared with those given above:—

Head & Body. mm.	No. of specimens.	Average % of Head & Body formed by H. & B., Tail, Hind-foot, Ear.
112	1	100—154—25·9—17·9
134 to 138	3	100—135—22 —15·4
142 to 149	10	100—141—21·2—15·6
150 to 159	30	100—137·5—20·3—14·9
160 to 169	27	100—136—19·6—14·5
170 to 174	3	100—127—19·2—14·5

The skull is slightly smaller than in European races of *rattus*; (average condylo-basal length 39·5, instead of 40·5); the cranial and zygomatic widths are, therefore, relatively a little greater. Its chief peculiarities appear to be the outcome of more powerful temporal muscles and slightly larger cheek-teeth. Thus the least posterior inter-temporal distance (dimension 7) is less, both in relation to the condylo-basal length and to the cranial width; the temporal lines are in contact with the ends of the interparietal in adults, so that the parietals have no inter-temporal connection with the supraoccipital; the temporal wing of each parietal is large, its length being fully equal to half the length of the squamosal. The palatal length, diastema, palatal foramina, masseteric

plates and tooth-rows are all longer relatively; the pterygoid region appears to be shortened, for while the distance condyle to bulla remains as in European races that between condyle and m. 3 is a little shorter. In several of these respects the skull of *R. r. arboreus* approaches that of *R. r. sikkimensis*; the bullæ are, however, obviously larger than in that species or its associate *R. r. tistæ*; in the present form moreover the orifices of the *canalis transversus* of the basisphenoid are distinctly visible, instead of being concealed in a direct ventral view.

*Local variation* :—

DALTONGANJ, Palamau (600').

The dimensions of the most important are :—

98	4661 ♂	20 March 1914,	164—230—34—25	
99	4715 ♀	24 „ „	166—256—32—24,	Weight 5¼ ozs.
	4759 ♀	29 „ „	168—243—34—25	„ 4¾ ozs.
Average of 17 (H. & B.)				134-168—155—221—31.3-23.4
„ % „ „				100—142—20.2-15.1

All have rather short, thin and harsh coats, pure white bellies, yellowish-white feet and cold tinted tails and backs. No. 98 in full pelage has the back tawny and lined with black hairs; 4733, a ♀ from the same locality and 4643, a ♂ from Palamau itself (16th March; 158—212—32—25; weight 4¼ ozs.) are quite similar. The other specimens are darker, blacker or greyer above; probably the pelage is fresher in them than in the three tawny individuals and the full dorsal coloration is not yet developed.

GAJHUNDI, Hazaribagh (1,000').

The following are the dimensions of the most important specimens :—

94	4877 ♂	10 May 1914,	168—208—30—24,	Weight 4½ ozs.
95	4886 ♂	11 „ „	168—211—34	5½ „
96	4888 ♀	11 „ „	166—233—32—24	5½ „
97	4898 ♀	13 „ „	164—208—31—24	5¼ „
Average of 19 (H. & B.)				148-168) 159-211-31.1-22.8
„ % „ „				100—133—19.6-14.3

Backs varying from tawny to dark greyish-brown and in this series the females appear to be generally darker than the males; dorsal tints always cold; bellies with hairs white throughout, often with a faint yellow tinge; feet white. No. 94 has a bright ochraceous patch on the right side of the throat and a much smaller spot on the left side.

PARESHNATH HILL, Hazaribagh (4,300').

The dimensions of the most important are :—

88	5130 ♂	13 June 1914	166—235—33—24,	Weight 5½ ozs.
89	5132 ♂	14 „ „	173—215—32—25	6¾ „



·90 5107 ♂, 10 June 1914 169—228—31—25 5½ ozs.  
 Average of 15 (H. & B. 138-173) 156-211-31·4-22·8  
 " % " " 100—135—20·1-14·6

These agree very closely with those from the other localities; the bellies in all are pure white, the feet light. No. 88 has a small yellow patch on the right side of the chest.

SINGAR, Gaya (1,400').

The dimensions of the three registered specimens are:—

·91 4955 ♂, 23 May 1914, 174—240—34—25, Weight 6½ ozs.  
 ·92 4931 ♀, 20 " " 158—217—33—25 5¼ "  
 ·93 4939 ♀, 21 " " 170—203—33—25 5¾ "  
 Average of 5 (H. & B. 151-174) 161-215-33—23·8  
 " " " 100—134—20·5-14·8

These and all the other specimens obtained by the Survey in Bihar and Orissa are really very much alike and call for no special comment. An old specimen (B. M. 66·12·28·6) collected by Mr. R. C. Beavan at Manbhum, Bengal, in January 1865, has longer and softer fur; its belly is of a pure but creamy white colour; its back is of a considerably brighter and warmer tint than are those of the specimens described above.

*Remarks*:—*R. r. arboreus* is a subspecies quite sharply differentiated from its allies, living on the other side of the Ganges, in Sikkim, Northern Bengal and Bhutan Douars, by its colder and more pallid coloration, its pure white belly (the phase or 'mutation' showing slaty bases to the ventral hairs being, apparently, quite absent), its shorter and especially thinner pelage, and its relatively long tail. The skull, in the hands of a patient observer, is also quite distinctive.

4. *Rattus rattus narbadw*, subsp. n.

1913. *Epinys rufescens*, var. with white underparts. Wroughton, Report No. 7, Central Provinces. *J. Bombay Nat. Hist. Soc.*, Vol. XXII, p. 54.

*Type*:—A female (B. M. 12·11·29·132; Original No. 774) collected at Sakot, Hoshangabad, on 11th January 1912, by Mr. C. A. Crump; presented to the British Museum by the Bombay Natural History Society.

*Distribution*:—Central Provinces.

*Material examined*:—Hoshangabad District.—1 (♀) from Sakot (1,200'); 8 (6 ♂, 2 ♀) from Dhain (1,400'); 3 (2 ♂, 1 ♀) from Bori (1,600'); 5 (3 ♂, 2 ♀) from Rarighat (2,500'); 2 (♂ and ♀) from Sonawanee, Balaghat (2,500'). Chanda District.—3 (1 ♂,

2 ♀) from Chanda (500'); 5 (3 ♂, 3 ♀) from Chickpalli (1,300'), Total 27 (16 ♂, 11 ♀). All these specimens were collected for the Mammal Survey by Mr. C. A. Crump; those since presented to the British Museum are registered under the serial number 12.11.29.—

*Description*.—In external appearance, size and proportions the present race is very similar to *R. r. arboreus*. The general dorsal colour is still colder, or greyer, on the average, than in the latter subspecies; and the long black hairs of the back show a more evident tendency, in *narbadae*, to form a mid-dorsal stripe of black. The belly is white or pale yellow, sharply contrasted with the flanks; usually the ventral hairs are light throughout, but in some specimens they have slaty bases—a feature not seen in any of those from Bihar and Orissa. The feet are light above and show in some individuals a yellowish tinge or obscure dusky markings. The mammary formula of females is normally 2-3=10; but in the type and two or three others it is 3-3=12; *narbadae* is apparently more variable in this respect than is *arboreus*.

The average dimensions of 26 adults (head and body ranging between 132 and 173) are:—

$$154-209-31.6-23 = 100-136-20.5-14.9$$

The following table shows the variation in the proportions which accompanies the increasing length of the head and body:—

Head and body. mm.	Number of specimens.	Average % of Head & body formed by H. & B. Tail, Hind-foot, Ear.
112	1	100—159 —26.8—19.7
130-139	2	100—138.5—23.3—17.7
140 to 149	6	100—139 —21.5—15.1
150 to 159	11	100—135 —20.25—14.9
160 to 169	6	100—134.5—20 —14.4
173	1	100—134 —19.7—14.5

The skull is slightly smaller than in *arboreus* (condylo-basa length averaging 38.4 instead of 39.5). The temporal muscles appear to be weaker (about as in *R. r. frugivorus*); for while the cranial width is relatively as great as in *arboreus*, the intertemporal distances (dimensions 6 and 7) are relatively greater and the zygomatic breadth is relatively less (see Table II); the parietals usually articulate by tongues with the supraoccipital above the temporal lines. The palatal length is shorter relatively—a difference apparently due to a shortening of the rostral portion of the palate.

From the skull of *R. r. frugivorus* it differs principally by its smaller size and shorter post-molar length—the latter character being due chiefly to a shortening of the pterygoid fossæ.

*Local variation.*—The following are the dimensions and notes on the coloration of the more important specimens from each of the different localities:—

SAKOT (1,200').

132 774 ♀, 11 Jan. 1912, 164—221—31—26, Weight  $4\frac{3}{4}$  ozs., (Type) Ventral hairs white throughout but with a trace of a yellow tinge; as regards the upper parts only the flanks and feet are lighter in colour than are the dark-bellied rats from this locality. The present specimen has 12 mammæ.

DHAIN (1,400').

128 879 ♂, 5 Feb. 1912 153—211—31—22, Weight  $4\frac{1}{2}$  ozs.

129 880 ♂, 5 " " 161—220—32—23 "  $4\frac{1}{4}$  "

130 901 ♂, 11 " " 153—200—33—22 " 4 "

133 873 ♀, 3 " " 147—197—32—21 "  $3\frac{1}{2}$  "

Of these specimens No. 128 has less black on the back and lighter feet than has No. 127, a dark-bellied rat from the same locality; the ventral hairs have deep slaty bases and a strong superficial wash of pale yellow. Nos. 129 and 130 are similar dorsally; but the ventral hairs (except for a few with grey bases on the chest of 129) are white throughout and their feet are white. No. 133 is like No. 130 but greyer on the back. Among the unregistered specimens Nos. 860 and 871 have white bellies and the ventral hairs light throughout; No. 881 has some hairs on chest with slaty bases and a well marked yellow wash. In some of the specimens the contrast between the dirty white or yellowish tinge of the belly and the grey flank colour is not very sharp.

BORI (1,600').

914 ♂, 17 Feb. 1912, 134—180—30—22, Weight  $2\frac{1}{4}$  ozs.

9 ♂, 27 " " 132—188—32—25 "  $2\frac{3}{8}$  "

9 ♀, 21 " " 173—232—34—25 "  $5\frac{1}{2}$  "

The two young males have thick soft fur; in No. 914 the belly is *Apodemus*-like, the ventral hairs having deep slaty bases and white tips with a well marked pectoral stripe and collar of buff; in No. 938, noted as having the testes fully developed, the ventral hairs are pure lemon colour to their bases. In the old female the fur is thick, but short and much harsher than in the young; the back is yellowish-brown, brighter than in the young, and with much black

along the middle line; the belly is a pure deep lemon to hair-bases; the feet have a dusky stripe above: and the mammary formula is 2-3=10.

#### RARIGHAT (2,500').

·131, 957 ♂, 4 March 1912, 163—210—33—23, Weight  $4\frac{3}{4}$  ozs.

·134, 959 ♀, 4 " " 158—225—34—27 "  $4\frac{3}{4}$  "

Specimens from this locality have longer, softer and thicker fur than have those from Dhain. The bellies are white with an occasional superficial tinge of yellow along the middle line; ventral hairs light to their bases; tails slightly paler below than above. No. 134 has 10 mammae.

#### SONAWANEE, BALAGHAT (2,500').

·139, 1348 ♂, 28 May 1912, 152—208—31—21, Weight  $3\frac{3}{4}$  ozs.

·140, 1350 ♀, 28 " " 158—217—31—24 "  $3\frac{1}{4}$  "

These dorsally are very similar to No. 115, a dark-bellied rat from the same locality, both have white bellies, but in the male many of the hairs have slaty bases while in the female all are white to their bases. The female has 10 mammae.

#### CHANDA (500').

·137, 1471 ♀, 19 June 1912, 161—212—33—23, Weight  $5\frac{1}{2}$  ozs.

·138, 1552 ♀, 27 " " 155—220—31—23 " 5 "

Both these specimens show 10 mammae and No. 137 contained 4 embryos. These are dull-coloured grey rats, with pure white or pale yellow bellies (ventral hairs unicoloured) and light feet. A male in full pelage (H. & B. 155) has short thin and rather spiny fur, the back being yellowish-brown lined with black; this is much like many of the specimens of *arboreus*.

#### CHICKPALLI, CHANDA (1,300').

·135, 1403 ♂, 8 June 1912, 159—200—32—23, Weight  $4\frac{1}{2}$  ozs.

·118, 1415 ♂, 10 " " 145—220—33—22 "  $3\frac{3}{4}$  "

·136, 1393 ♀, 6 " " 158—212—31—22 " 4 "

The bellies are white or pale yellow; in No. 118 many of the ventral hairs have dilute slaty bases but in the others they are light throughout. Both females from this locality have 10 mammae.

Before offering some remarks upon the status of *R. r. narbadæ* it is necessary to describe briefly the dark-bellied rats associated with it in the Central Provinces. The following is the list of the material, collected by Mr. C. A. Crump, before me:—9 (4 ♂, 5 ♀) from Sakot; 1 (♀) from Dhain; 2 (♂) from Bori; 2 (♂) from Soharpur, (1,000'); 1 (♂) from Rarighat; 9 (5 ♂, 4 ♀) from Sonawanee, Balaghat; 4 (1 ♂, 3 ♀) from Chanda; and 5 (4 ♂, 1 ♀) from Chickpalli. Total 33 (19 ♂, 14 ♀).

The following are the dimensions of the principal specimens :—

## SAKOT.

120 ♂, 24 Jan. 1912,	133—175—30—22,	Weight 3	ozs.
121 ♂, 29 „ „	139—181—31—21	„ 3	„
125 ♀, 22 „ „	139—180—30—22	„ 3 $\frac{1}{4}$	„
126 ♀, 24 „ „	175—214—31—25	„ 5 $\frac{1}{4}$	„

## DHAIN.

127 ♀, 4 Feb. 1912,	147—203—31—21,	Weight 3 $\frac{3}{4}$	ozs.
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## BORI.

122 ♂, 20 Feb. 1912,	163—224—35—24,	Weight 4 $\frac{1}{4}$	ozs.
123 ♂, 20 „ „	166—233—35—25	„ 4 $\frac{3}{4}$	„

## SOHAGPUR.

124 ♂, 1 April 1912,	179—223—33—24,	Weight 5 $\frac{1}{2}$	ozs.
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## BALAGHAT.

113 ♂, 27 May 1912,	159—190—33—24,	Weight 4 $\frac{3}{4}$	ozs.
114 ♂, 29 „ „	155—213—32—23	„ 4	„
115 ♀, 27 „ „	158—215—32—22	„ 4	„
116 ♀, 29 „ „	146—215—30—	„ 4	„

## CHANDA.

119 ♀, 21 June 1912,	150—210—32,	Weight 4 $\frac{1}{4}$	ozs.
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## CHICKPALLI.

117 ♂, 8 June 1912,	158—225—32—24,	Weight 5	ozs.
118 ♂, 8 „ „	146—220—33—22	„ 3 $\frac{3}{4}$	„

The averages of 33 (H. & B. 130 to 179) from all localities are :—  
148—202—31—22·6=100—136·5—21—15·3.

The averages of 15 (H. & B. 130 to 179) from Hoshangabad and Rarighat :—

$$147—191—31·2—23·1=100—130—21·2—15·7.$$

The averages of 5 (H. & B. 136 to 158) from Chickpalli are :—

$$145—221—31·2—22·2=100—152—21·6—15·3.$$

The variation of proportions with increasing body length is shown below. The relative tail length exhibits much irregularity when the 33 specimens are treated as a whole; but this irregularity is, to some extent, diminished by keeping the rats from Hoshangabad apart from those from Chanda. Although short-tailed rats appear to be more frequent in the former district and long-tailed

rats more frequent in the latter, both types occur together in each locality:—

Head & Body in mm.	No. of specimens.	% of H. & B. formed by tail.	Hoshangabad.		Chanda.	
130 to 139	11	134.5	8	100-129-22.2-16.6	3	100-149-22.1-15.7
140 to 149	9	142.5	2	100-130-20 -15.2	7	100-146-21.2-15.2
150 to 159	8	135	1	100- -20.3-15.7	7	100-135-20.4-14.7
160 to 169	3	140	2	100-139-21.3-14.9	1	100-141-19.1-14.2
170 to 179	2	123	2	100-123-18.1-13.8		

On comparing this table with that given at p. 75 it will be seen that the white bellied *R. r. narbadæ*, as regards tail length, approximately represents the mean between the long-tailed and short-tailed, dark-bellied types just discussed.

In the quality of the pelage and in the dorsal colour these dark-bellied rats are very similar to the typical white bellied *R. r. narbadæ*; possibly the general tone of the backs is a little darker and greyer. The grey flank colour merges insensibly into the dusky tint of the belly. The ventral hairs are slaty throughout the greater part of their length, but their extreme tips are frequently yellowish and impart a very characteristic rusty tinge or bloom to the undersurface; this rustiness and the roughness of the ventral surface is very different in appearance from the bluish, sleek belly of *R. r. rattus*. Pale yellow or dirty white chest spots are not infrequently present. The feet are usually dusky brown above.

As will be seen from Tables I and II the skull agrees very closely in size and proportions with that of typical *narbadæ*; and I am quite unable to distinguish them.

*Remarks*:—I have had a good deal of difficulty in making up my mind as to the status of the rats of the Central Provinces, but after considering the facts in connection with what is found elsewhere, *e.g.*, in Kathiawar, it seems difficult to avoid the conclusion that in this district the dark bellied form is merely a parasitic development from the local white bellied race. With the acquisition of parasitic habits the stock seems to have become richer in pigment, and the tail length has alternatively been either greatly increased or greatly diminished. No change in the head muscles or skull has as yet been brought about. But the wild and the parasitic stocks are still mingled together in each locality; and doubtless each reacts on the other. In this probably lies the explanation



of the fact that the degree of individual variation observable in *narbadæ* is far higher than that which we observed in *arboreus*.

As regards the relation of *narbadæ* with *arboreus*, a comparison of the typical white bellied series with those from Bihar and Orissa shows clearly that, while in both races old animals have a bright yellow-brown dorsal coloration and younger rats a greyer or less yellow one, the race from the Central Provinces is, on the average, one with colder dorsal tints. These colder tints are coupled with a greater tendency of the long black hairs to arrange themselves in a mid-dorsal stripe. These differences seem to have a geographical value. The smaller size and less modified condition of the skull in *narbadæ*, correlated as they appear to be with weaker temporal muscles, are still more striking characters—although, in part, they may be retrogressions. There seems thus to be ample justification for establishing *R. r. narbadæ* as a subspecies distinct from *arboreus*.

#### 5. *Rattus rattus girensis*, subsp. n.

1913. *Epimys rufescens*, var. with white underparts. Ryley, Report No. 10. Kathiawar, *J. Bom. Nat. Hist. Soc.*, XXI, p. 481, 1913, *Epimys rufescens*. Ryley, *loc. cit.* (in part).

*Type*:—A female (B. M. No. 13·8·8·125; Original No. 1866), collected at Sasan, Junagadh, on 6th November 1912, by Mr. C. A. Crump for the Mammal Survey; presented to the National Collection by the Bombay Natural History Society.

*Distribution*:—Southern Kathiawar; abundant at the edge of the Gir Forest near Sasan, where it leads a natural outdoor life.

*Material Examined*:—26 (14 ♂, 12 ♀) from Sasan (400'); 1 (♂) from Keshod (300'); and 2 (♂ and ♀) from Talala (200'). Total 29 (16 ♂, 13 ♀); all collected for the Mammal Survey by Mr. C. A. Crump. Those since presented to the British Museum are registered under the serial number 13·8·8.—

*Description*:—In this form the fur is rather short and harsh, but usually not spiny. The general colour of the back is a cold drab, much like that of the duller coloured specimens of *narbadæ*, darkened along the mid-dorsal line by a greater or less number of long black hairs: individuals, however, present the usual range of variation in dorsal colour from mixtures of yellowish-brown and black to others in which the yellowish-brown is more or less completely replaced by grey. The belly is of a pure but dull white and it is sharply contrasted along a perfectly regular line with the dark grey flanks; the ventral hairs are usually white from the tips to the basis. The feet are usually light above, their colour varying between a dirty white and a light yellowish-brown, with occasionally faint dusky markings.



The following are the dimensions of the more important specimens:—

SASAN (400').

- 122. 1862 ♂, 31 Oct. 1912, 159—209—32—21, Weight  $4\frac{1}{2}$  ozs.  
 ·123. 1863 ♂, 1 Nov. „, 154—177—32—23— „ 5 „  
       1934 ♂, 8 „ „, 163—188—31—22— „ 5 „  
 ·124. 1865 ♀, 6 „ „, 142—191—30—21— „  $3\frac{3}{4}$  „  
 ·125. 1866 ♀, 6 „ „, 160—215—30—23— „  $5\frac{1}{4}$  type

The average of 29 in adult pelage (Head and body 119 to 165):—

145—194—31·1—20·9=100—134—21·4—14·4

The change in the proportions with growth is as follows:—

Head and body, mm.	No. of specimens.	Average of head & body formed by H. & B. Tail, Hind-foot, Ear.
119 to 120	2	100—140—23·8—15·5
130 to 139	5	100—140—22·7—14·75
140 to 149	12	100—136—22· —14·5
150 to 159	6	100—129—20·3—14·3
160 to 165	4	100—129—19·4—13·7

The tail is thus distinctly shorter in adults than it is in *narbade* or *arboreus* (cf., tables at pp. 78 and 75 ).

The mammae could be counted in 8 of the females; in 6 (including the type) the formula is 2-3-10; 2 have 11 mammae each, an extra one being present on one side in the pectoral region.

The skull is small (condylo-basal length averaging 37·1 instead of 38·4 as in *narbade*), about 3 mm. shorter than in *alexandrinus* and the cranial width is relatively a little greater than in the latter. Judging from the intertemporal distances (dimensions 6 and 7, Table II) the temporal muscles are scarcely weaker relatively than in *arboreus*; but the parietals articulate, above the temporal lines, rather broadly with the supraoccipital and the zygomatic breadth is scarcely greater relatively than in *narbade*. As in the latter form the palate and diastema are relatively slightly shorter than in *arboreus*, but the palatal foramina are a little longer. In several respects the cranial proportions are intermediate between those of *arboreus* and the European races of *rattus*.

*Local Variation*:—Little need be said on this score. The two from Talala (H. & B. 120 and 142) are very dark animals with dirty white bellies and dusky feet; these were taken in a hut. Four others from Sasan were also caught in a hut and these similarly possess such a dingy appearance that Miss Ryley listed them

as "*Epinys rufescens*"; they, however, clearly belong to the white bellied race. The other specimens were trapped out of doors. In one only few of the chest hairs have slaty bases; in a few there is a slight trace of a ventral suffusion of yellow.

*R. r. girensis* appears to be confined to that part of Kathiawar which lies to the south of the Gir Hills. Although apparently not often found actually together, it is accompanied in this district by a dark bellied form. The latter is represented by 17 specimens among the material before me. Of these 17, only 1 (♀) was taken at Sasan; and this was caught in the hut mentioned above in the company of white bellied specimens; 7 (3 ♂, 4 ♀) are from Keshod, where 4 of them were caught in a fig tree and whence only 1 white bellied rat was obtained. The remaining 9 (3 ♂, 6 ♀) are from Junagadh (350' to 480'); of these only 1 was taken out of doors and no white bellied rats were found at this locality. All with the exception of the 5 mentioned appear to have been trapped by Mr. Crump in huts of other dwellings.

Dark bellied specimens were obtained also from three localities in northern Kathiawar. Of these the following 20 are before me:—16 (8 ♂, 8 ♀) from Rajkot (100'); (♀) from Saturpur (20'); and 3 (1 ♂, 2 ♀) from Vankaneer (500'). None of these is marked by Mr. Crump as having been captured out of doors.

As regards colour these northern and southern specimens are similar; dorsally they are much like true *girensis* as above described, although the general tint of the back perhaps averages slightly darker. The flanks pass insensibly into the dark, rusty tinged belly. Several show white pectoral spots. The feet are usually dark brown above, but they are light coloured in a few of the specimens. The mammae were counted in 12 females; 9 have 10 as usual; 1 has 11 and 2 have 12; the additions in each case are pectoral.

The following are the dimensions of the more important specimens:—

#### JUNAGADH (350').

121 ♂, 26 Sept. 1912, 157—206—32—23 Weight 4 ozs.

#### KESHOD (300').

116 ♂, 7 Oct. 1912, 166— —33—23 „ 4½ „

117 ♀, 7 „ „ 160—211—33—24 „ 5½ „

118 ♀, 7 „ „ 150—224—33—23 „ 4 „

#### RAJKOT (100').

119 ♂, 21 Dec. 1912, 150—195—30—21 „ 5¼ „

120 ♀, 25 „ „ 150—192—30—21 „ 3¾ „

The changes in proportions transpiring with growth may be tabulated as follows :—

Southern Kathiawar.			Northern Kathiawar.		
122			1	100-116-22.1-15.6	
130 to 139	2	100-139-22.5-14.4	3	100-135-22.1-15.1	
140 to 149	2	100-144-21.5-14.1	8	100-130.5-21.6-15.25	
150 to 159	9	100-136-20.7-14.5	7	100-125.5-19.9-13.9	
160 to 166	4	100-123-19.4-13.6	1	100-19.4-15.6	

This table brings out two interesting facts. If firstly the figures given for the southern specimens be compared with those of the table at p. 82 it will be seen that the three largest stages are represented by rats with tails either much longer or much shorter relatively than those of equally grown individuals of the wild *girensis* from the same district. That is to say, we meet with an exactly similar departure from type in the dark bellied form of this district as we do in the Central Provinces. Secondly the northern dark bellied rats are distinguished from both *girensis* and the southern dark bellied specimens in every stage of growth by their shorter tails.

The skull is similar in both northern and southern dark bellied rats and as regards size it agrees with that of *girensis*. But it presents characters which suggest that the dark bellied rat is the indoor animal, living on a softer diet and therefore developing a weaker set of jaw muscles than those of the outdoor, harder living, white bellied *girensis*. Thus the intertemporal distances are increased (see Table II), both in relation to the condylo-basal length and to the cranial width; this increase indicates a diminished area of origin for the temporal muscles. The masseteric plate is correspondingly a little narrower. The anterior palatal foramina are as large as in *girensis*; while the palatal length is less and the post-molar length greater—each of these two last dimensions being relatively nearly as in European races.

*Remarks* :—*R. r. girensis* is widely separated geographically from all the other white bellied races of India. Although in colour it closely resembles *narbadae* it is quite satisfactorily distinguished from the latter by its cranial peculiarities and shorter tail, and it undoubtedly deserves subspecific recognition.

The dark bellied rats of Kathiawar are, in my opinion, plainly indoor developments from *girensis*. The southern stock is already quite clearly differentiated by its cranial characters and colour from

its neighbour and parent; the northern race more completely cut off from the wild parent, has moreover shortened its tail. This sharp differentiation between the wild parent and its parasitic offspring is in striking contrast with the relations between the corresponding forms of the Central Provinces; but this contrast finds a ready explanation when one considers the restricted distribution of the parent and the well marked differences of station in Kathiawar on the one hand, and the universal distribution and complete confusion of stocks in the Central Provinces on the other.

6. *Rattus rattus sataræ*, subsp. n.

1913. *Epimys rufescens*, variety with white underparts. Wroughton, Report No. 22, Koyna Valley. *J. Bombay Nat. Hist. Soc.*, Vol. XXIV, p. 315.

*Type*:—A female (B. M. No. 15.7.3.56; Original No. 138) collected at Ghatmatha, Satara District, on 18th December 1914, by Mr. S. H. Prater for the Mammal Survey; presented to the British Museum by the Bombay Natural History Society.

*Distribution*:—Known at present only from the edge of the Western Ghats at the type locality altitude about 2,000'.

*Material examined*:—7 (1 ♂, 6 ♀) all collected for the Mammal Survey by Mr. S. H. Prater at the type locality; the specimens presented to the British Museum are registered under the serial number 15-7-3.

*Description*:—This is a soft and fully furred subspecies, its coat being distinctly longer and thicker than in *arboreus*, *narbadae* and *girensis*. In fresh pelage the general colour of the back is a bright "clay" or golden brown, much darkened by long black hairs (Nos. 137, 138 and 141); in what is possibly a less developed phase, of the coloration the golden tint is duller and the black less intense (No. 140), and in an old specimen (No. 139) very few black hairs are present and the back is bleached to an almost uniform light golden brown. The underparts are clothed throughout with thick, long and soft creamy white fur, the hairs being everywhere light to their bases. The feet are yellowish brown. The tails, unicoloured and dusky, are remarkable for their very great length. The following are the dimensions:—

•55, 137 ♂, 18	Dec. 1914, 141-243-32-24=100-172-22-7-17
136 ♀, 18	" " 149-230-33-25=100-154-22-2-16-8
•56, 138 ♀, 18	" " 146-233-32-25=100-160-21-9-17-1
•57, 139 ♀, 19	" " 165-245-32-27=100-148-19-4-16-4
•58, 140 ♀, 19	" " 151-230-31-25=100-152-20-5-16-5
141 ♀, 19	" " 156-250-35-23=100-160-22-5-14-7
Juv. 142 ♀, 19	" " 121-182-30-23=100-150-24-8-19
Average of 6 adults :—151-238-32-5-24-8=100-158-21-6-16-4	

The young specimen is, of course, much duller than are the adults; it shows a moult patch on the head between the ears.

The mammae were ascertained in 4 of the females to be 2-3=10.

The skull is about as large as in *arboreus* (condylo-basal length averaging 39·7), but the zygomatic breadth is relatively small, about as in *narbadæ*. The cranial and greatest intertemporal widths are very great, but the temporal lines curve inwards so much posteriorly that the least intertemporal width behind is, relatively to the condylo-basal length, not much greater than in *frugivorus* and in relation to the cranial width is 2% less than in the latter. The temporal lines are quite faintly marked and the supraorbital beads are very weakly developed. The parietals articulate broadly with the supraoccipital above the temporal lines. The palatal length is  $2\frac{1}{2}\%$  longer than in European races; the diastema, anterior palatal foramina and tooth-rows all showing increased lengths. On the other hand both post-molar lengths (condyle to m. 3, condyle to bulla) are reduced, the pterygoid fossæ in particular being short. The masseteric plate is also rather narrow. From these features it would appear that all the jaw muscles are weak.

*Remarks* :—This is apparently a very sharply defined local race distinguished from all other Indian subspecies by its peculiar skull and relatively long tail. By its bright dorsal coloration it resembles the form occurring in the southern half of the peninsula and differs from the duller subspecies of Bengal and the Central Provinces. The dark bellied rats collected at Ghatmatha and in the Koyna Valley immediately below seem to have no connection with *sataræ* and to have been derived from some other stock.

(To be continued.)

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